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SCREW CAP FOR A PRESSURIZED CONTAINER

BACKGROUND OF THE INVENTION

[0001] The present invention relates to a screw cap for containers with a threaded neck, in particular PET (polyethylene terephthlate) bottles, which are designed to hold drinks containing CO_2, with a head plate, a roughly cylindrical cap shell with internal thread, an essentially cylindrical inner sealing web extending from the head plate with a continuous annular region projecting radially outwards and an outer, essentially cylindrical sealing web concentrically surrounding the inner sealing web, the maximum external radius of the inner sealing web and the minimum internal radius of the outer sealing web differing only slightly and preferably by less than 2 mm and in particular by less than 1 mm, and being designed to accommodate and seal the upper region of a bottle neck in the thus-formed intermediate space.

[0002] Such a screw cap is already known from European patent application no. 98 909 299, filed by the same applicant as the present application and corresponding to US Patent 6,325,226.

[0003] This known closure has outstanding sealing properties which have resulted in considerable market success. It hardly seems possible to come up with any feasible means that would further improve the sealing efficiency and that is not the intention of the present invention. Rather, the screw cap according to the present invention uses the same sealing principle, based on the combination of an inner seal in the form of a radially inner sealing web with a cross-section resembling an olive, which is therefore also referred to as a “sealing olive”, in conjunction with a cylindrical outer sealing web, wherein the special geometry of the two sealing webs and further elements provided on the closure, in combination with one another, achieve the special sealing action.

[0004] The known screw cap is usually used to close PET bottles which contain carbonated drinks. These PET bottles and in particular their threaded necks are standardized and there are only a few standard types which are overall relatively similar to one another, although the specific dimensions of the corresponding closures are in each case adapted precisely to one of these respective standard types.

[0005] The wall thickness of the bottle neck rim of such PET bottles is mostly less than 2 and often even less than 1.5 mm, e.g. 1.2 mm. In order to achieve an adequate sealing action, the maximum external radius of the inner sealing web must be significantly bigger, i.e. by at least 0.3 to 0.5 mm, than the internal radius of the bottle neck rim against which the inner sealing web rests in a sealing manner. The internal radius of the outer sealing web must simultaneously also be significantly smaller, i.e. mostly by 0.5 mm or more, than the external radius of the bottle neck rim against which the outer sealing web rests in a sealing manner. This means that the intermediate space between the inner web and the outer web is relatively slim, with typical radial dimensions of only 0.5 mm. Depending on the wall thickness of the bottle neck rim, it may naturally also be bigger or somewhat smaller.

[0006] At the same time, another bead is also generally provided, surrounding the outer sealing web at a distance, the internal radius of which is bigger than the external diameter of the bottle neck rim by less than the thickness of the outer sealing web, which means that the outer sealing web is pressed between the bottle neck rim and the bead or pushed against the bottle neck by the bead when the cap is screwed on, thereby contributing to the good sealing effect. The inner sealing web simultaneously fulfils a centring function, only the cooperation of all elements of the closure guaranteeing a surprisingly dramatic improvement in the sealing properties.

[0007] These outstanding sealing properties of the known closure, of which the present invention also makes use, may nevertheless have a detrimental effect under extreme conditions. For example, extremely high pressures can build up in such a PET bottle under extremely high outdoor temperatures, particularly if suitably filled bottles are exposed to direct sunlight, combined with a particularly high proportion of carbon dioxide in the liquid or beverage. This causes a very considerable strain, both on the bottle and on the closure, and can also lead to a clearly visible bulging in the main body of the bottle. It would therefore seem desirable to avoid these extremely high pressures, especially in PET bottles used for beverages.

[0008] In view of the state of the art described above, the object of the invention is therefore to create a screw cap which on the one hand generally preserves the outstanding sealing properties of the known screw cap, even under very rough external conditions, but is simultaneously also capable of limiting the pressures which occur in a container closed with the screw cap without loss of sealing function.

BRIEF SUMMARY OF THE INVENTION

[0009] This object is achieved in that the screw cap is provided with structures which restrict the axial depth to which a bottle neck rim penetrates the intermediate space between the inner and outer sealing web, irrespective of the limiting, achieved alone by the sealing webs and base of the intermediate space, of such penetration of the intermediate space by the bottle neck rim.

[0010] More particularly, the invention is a screw cap for containers with a threaded neck, in particular PET bottles, which are designed to hold drinks containing CO_2. The screw cap has a head plate (1), a roughly cylindrical cap shell (2) with internal thread (3), an essentially cylindrical inner sealing web (4) extending from the head plate (1) with a continuous annular region projecting radially outwards and an outer, essentially cylindrical sealing web (5) concentrically surrounding the inner sealing web (4). The maximum external radius of the inner sealing web and the minimum internal radius of the outer sealing web differ only slightly and preferably by less than 2 mm and more preferably by less than 1 mm. The inner and outer sealing webs (4, 5) are specifically designed to accommodate the upper region of a bottle neck (11) in the annular intermediate space formed between them, wherein structures (6, 7) are provided which limit the axial depth by which the bottle neck rim (11) penetrates the intermediate space between the inner (4) and outer sealing web (5).

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

Figure 1 shows a view, in axial direction from inside, of a closure cap according to the invention,

Figure 2 shows a section containing the axis through the closure cap represented in Figure 1,

Figure 3 shows an enlarged section of the closure cap according to Figure 1,

Figure 4 shows a screw cap represented partly in section and screwed onto a bottle neck and

Figure 5 shows a section enlargement of the area circled in Figure 4.

DETAILED DESCRIPTION OF THE INVENTION

[0011] Irrespective of their influence on reducing the internal pressure inside a bottle, the structures according to the invention, which act as an axial stop for a bottle neck on which the cap is screwed, also have an advantageous effect with regard to the attachment of the closures by

machine. When screwing on a closure by machine, on which the present invention is based, it can happen that the closure becomes twisted when being screwed on or else an annular bead which may be provided externally to the outer sealing web sits on the upper thread pitch. The latter is particularly undesirable if the upper thread pitch is not designed for such a seating but extends with its top end inclined relative to the closing axis. In this case, the closure can become tilted. Since the webs according to the invention are provided between the inner and outer sealing strips, they act as an axial stop which immediately leads to a sharp increase in torque as the closure is screwed onto a bottle neck, as soon as the end face of the bottle neck reaches the webs. It goes without saying that any cylindrical bead outside the outer sealing strip is designed so that it does not come into contact with the thread before the end face of the bottle neck reaches the named webs.

[0012] In principle a statically measured torque, which is determined in appropriate tests for the particular type of cap, is set in capping machines for every cap head. However, during the closing process, an additional torque occurs due to the kinetic energy, which is to be decelerated, of the rapidly rotating cap head, and whilst allowance can be made for this, it varies due to mostly unavoidable fluctuations in the line speed, and in order to produce a sufficiently high torque even when machines are operating slowly, a correspondingly high torque value is set which can then lead to the closure being slightly over-rotated when the machines are running quickly again. The torque which occurs when the cap is over-rotated is also referred to in the technical language by the English term "strip-torque".

[0013] It has transpired that the webs according to the invention perceptibly increase this torque needed to over-rotate the closure, which can therefore help to prevent over-rotation, even when relatively high static torque values are set. Furthermore, the sharp increase in torque which occurs when the bottle neck mouth hits the webs according to the invention can also be used to control the machine in order to halt the screwing-on process at the beginning of such an increase.

[0014] Even though the measures according to the invention are not intended as a means of setting the tightness and safety of the cap against excess pressure, or the mentioned venting effect does not occur due to the design of the seals, the webs according to the invention are, from the point of view of an improvement in the properties, nevertheless useful, in view of the mentioned excess torque, when screwing on the closures by machine.

[0015] Expediently, the structures are designed so that a distance of between 0.5 and 1.5 mm is left between the plane defined by the internal face of the head plate and the plane defined by the upper bottle neck rim, provided that, in this connection, the base of the intermediate space between the sealing webs constituting the actual reference point for the axial position of the bottle neck rim lies more or less in the inner plane of the head plate. If this is not the case, the corresponding distance should be better determined relative to the plane defined by the base of this intermediate space.

[0016] In the preferred version of the present invention, the structures for limiting the penetration of the intermediate space between sealing webs by the bottle neck rim consist of elevations or webs which extend into the intermediate space from the base of the intermediate space. In this way, when the closure cap is screwed onto a bottle neck, these elevations or webs act as stops for the bottle neck rim that prevent further penetration of the intermediate space between the sealing webs by the bottle neck rim. As a result of the material and their dimensions, these stops are not rigid but are elastically flexible to a certain degree. It has proved to be expedient if the webs or elevations have an axial height (measured respectively from the base of the intermediate space) of between 0.3 and 2.5 mm, preferably in the range of 0.5 to 1.8 mm.

[0017] By base of the intermediate space is meant the section of the head plate between the sealing webs at its deepest point.

[0018] The width of the webs in peripheral direction should be sufficient to permit them to act as stops and not, for their part, to be excessively elastically deformed and pushed in themselves. To this end, a width of the webs of 0.3 to 2 mm has proved to be useful.

[0019] In the preferred version, several webs are distributed at roughly equal angular distances along the annular intermediate space. In the preferred version of the invention, for example, six webs are arranged in the intermediate space, in each case at angular distances of approximately 60° and extend in axial direction into the intermediate space by approximately 1.5 to 1.8 mm from the deepest base of the intermediate space.

[0020] It has also proved to be expedient if the wall thickness of the head plate in the region of the intermediate space, to be more precise the minimum wall thickness of the head plate in this region, is somewhat smaller than the wall thickness of the head plate in the rest of the region, that is to say in particular in the region immediately inside the inner sealing web. The head plate typically has a largely constant wall thickness of the order of 0.8 to 2.5 mm, mostly

between 1 and 1.5 mm, and may have an additional thickness or camber at the centre, for example. The (minimum) wall thickness of the head plate in the intermediate space between the sealing webs is expediently 10 to 50%, preferably approximately 20 to 40%, smaller than radially inside the inner sealing web.

[0021] In an alternative version of the invention, the structures for limiting the penetration of the intermediate space between the inner and outer sealing webs by the bottle neck rim are provided not between these sealing webs but e.g. radially outside the sealing webs. To this end, there may be provided a bead lying radially outside the outer sealing web and designed to act as a stop for the upper threaded edge of a bottle neck rim which is elastic to a greater or lesser degree, wherein the stop surface of the bead, which runs essentially in a plane perpendicular to the screw cap, has from the base of the intermediate space an axial distance that is 0.3 to 2 mm, preferably 0.5 to 1.5 mm bigger than the axial distance of the upper threaded edge from the upper rim surface of the threaded neck of a bottle for which the screw cap is provided.

[0022] Such a version is suitable in particular for bottle necks, the thread of which extends over a considerable peripheral section in a plane perpendicular to the axis of the bottle neck. In such a thread, the upper flattened thread edge lies over a correspondingly large peripheral portion against the stop surface of the bead, thereby ensuring that the axial position of the bottle neck rim between the two sealing strips is clearly defined. As a result of the resting either of the thread edge against the stop surface of a bead or the bottle neck rim directly against the web surfaces between the sealing webs, the sealing strips are penetrated less deeply by the bottle neck rim than would be possible without corresponding stops, the elasticity of the stops still permitting a certain scope for movement so that the exact axial position of the bottle neck between the sealing webs in the closure can still be adjusted within certain narrower limits by screwing down to a greater or lesser degree or by the rotational position of the cap thread relative to the bottle neck thread.

[0023] With the conventional closure, penetration by the bottle neck rim was essentially limited in that the intermediate space between the two sealing webs became increasingly narrow towards the head plate, which effectively produced a resistance to prevent the bottle neck rim from being pushed in further. This being the case, the top edge of the bottle neck was able to reach a position very close to the inner plane of the head plate and lay close to the base of the

intermediate space between the sealing webs. As a result of the dimensions according to the invention, the bottle neck rim is retained at a distance of the order of 1 mm from the inner plane of the head plate in axial direction and at a somewhat bigger distance from the base of the intermediate space between the two sealing webs, provided that the head plate is of a somewhat thinner design in the region of this base than in the rest of the head plate, and thus the base of this intermediate space is additionally somewhat offset from the inner plane of the head plate. Naturally, the position relative to the inner plane of the head plate may deviate from the specified dimensions to a greater degree if the thickness of the head plate is modified. Ultimately, the reference point is the base of the mentioned intermediate space.

[0024] The sealing engagement of the bottle neck rim with the two sealing webs remains essentially of the same quality as that of the known closure, although the sealing webs are spread somewhat less – particularly in the vicinity of where they rest against the head plate – than would be the case if the bottle neck rim were allowed to penetrate the intermediate space further to the point at which the intermediate space is already significantly narrower, so that in this region, the outer sealing web in particular would be placed under even more tension and therefore provide an even better seal.

[0025] As a result of the design according to the invention, once the internal pressure in a container reaches a certain point, which may be significantly above 7 bar, due to excessively high temperatures, some gas is able to escape from the bottle neck and between the bottle neck rim and sealing webs until the pressure is sufficiently reduced (specifically to a value somewhat below 7 bar, for example). The closure according to the invention therefore ensures that a sufficient and desired excess pressure is always maintained in the container and only an excessively high excess pressure is relieved. This allows a small amount of excessive carbon dioxide to escape, especially if an excessively high amount of carbon dioxide was released into the liquid. Due to the fact that a sufficient excess pressure is maintained, however, the CO_2 is completely or else largely prevented from escaping from the liquid.

[0026] Further advantages, features and possible applications of the present invention result from the following description of a preferred version and related figures.

[0027] Figures 1 to 3 show a closure cap denoted as a whole by number 10, which essentially consists of a head plate 1 (also referred to as a cap base) and a cap shell 2. The cap shell has an internal thread 3 and a tear-off strip at its bottom edge, which is provided as a

guarantee element, its state indicating whether the closure has already been opened. As this tear-off strip is known per se and not relevant to the present invention, it will not be described in more detail here.

[0028] Two continuously annular sealing webs 4 and 5 extend inwards from the head plate in axial direction. The radially inner sealing web is somewhat stronger and also axially longer than the radially outer sealing web 4. The maximum thickness of the inner sealing web is e.g. 1 to 1.5 mm, and its minimum thickness is of the order of 0.8 mm, the free bottom edge being of an angled design at its external face, which is intended to make it easier for the inner sealing web 4 to slide into a bottle neck. As a result of the virtually olive-shaped cross section of at least the external face of the sealing web 4, this sealing web will also be referred to in the following as a "sealing olive" according to a linguistic usage that has now become customary. Radially outside the annular sealing olive 4, there is shown a virtually cylindrical and somewhat thinner sealing web 5, the free end of which is somewhat angled and rounded at the internal face, which again is intended to make it easier for the outer sealing web 5 to slide on the rim of the bottle neck. The intermediate clearance space between the inner and outer sealing web 4 and 5 is relatively slim and is at most essentially no more than 1 mm or even less. The maximum radius of the inner sealing web differs from the minimum radius of the outer sealing web by an even smaller amount, this difference typically being only of the order of 0.5 mm.

[0029] The intermediate space between the inner sealing web 4 and the outer sealing web 5 is denoted by reference number 9.

[0030] The essential elements of the screw cap according to the invention just described are again shown in Figure 3 in an axial top view of the interior of the screw cap 10. The annular and somewhat thicker sealing web or sealing olive 4 extending radially from inside towards the outside is shown and, immediately radially outside same, the intermediate space 9 as well as the sealing strips 5 immediately radially outside the intermediate space 9. Adjoining it towards the exterior is the cap shell 2 with the internal thread 3 and the inner bead 7.

[0031] In both Figure 1 and Figure 3, the webs 6 according to the invention are shown in the intermediate space 9 at angular distances of approximately 60°. The section plane according to Figure 2 runs straight through two oppositely lying webs 6, so that the axial height of the webs 6 is also shown in Figure 2.

[0032] Figure 4 shows the closure cap 10 according to the invention screwed onto a bottle neck as far as the elastic stops. Figure 5 shows another enlarged section from Figure 4. Although the adherence to specific dimensions is not crucial in every case, it may be pointed out that the screw cap according to the invention is represented essentially true to scale in these drawings, Figures 1, 2 and 4 showing the closure on a scale of 2:1, Figure 3 showing the closure on a scale of 5:1 and Figure 5 showing the section from Figure 4 approximately on a scale of 10:1 of the original closure. It can be seen from this that the thickness D of the head plate is approximately 1.5 mm, whilst the thickness d of the head plate at the deepest point of the base of the intermediate space 6 is somewhat smaller, being e.g. 1.1 to 1.4 mm. The thread 3 of the screw cap 2 is screwed onto the thread of the bottleneck 11, to the extent that the bottle neck rim penetrates between the two sealing webs 4, 5 until it rests against a web 6, of which a total of six stops 6 are uniformly distributed over the periphery of the intermediate space 9. 8 denotes an external fluting of the screw cap 10, the purpose of which is to provide a solid and secure grip on the screw cap when unscrewing and screwing the screw cap.

[0033] Without the webs or stop elements 6, the bottle neck 11 would be easily able to further penetrate the intermediate space 9 by 0.5 to 1 mm, the outer sealing web 5 in particular being expanded even further and being placed under tension, thereby resting more firmly and tightly against the bottle neck rim. The somewhat thinner wall thickness d of the head plate in the region of the intermediate space 9 also has the purpose of imparting additional elasticity and expandability to the head plate in this region, which also contributes to the firm and tight engagement of the two inner and outer sealing webs 4, 5 with the bottle neck rim.

[0034] The webs 6 ensure that this sealing engagement is preserved on the one hand but not quite as strongly as without the webs 6. As a result, any excessive excess pressure in the bottle is relieved. Both the bottle itself and the closure are therefore subjected to less strain.

[0035] Even though, as already mentioned, adherence to the exact dimensions, as shown in the figures, does not appear necessary, it is nevertheless to be assumed that the advantageous effects of the closure according to the invention are based on the fact that it reacts relatively insensitively to tolerance deviations of the bottle neck and also of the actual screw cap itself. This is presumably due to the fact that, in addition to its other special geometric features, this closure has elastic properties, as defined in the claims, because of the material used (polyolefin) and the wall thicknesses of the sealing webs and head plate in the region between the sealing

webs, as well as the dimensions of the stop elements or webs, which elastic properties are particularly favourable to the absorption of tolerance deviations without detrimentally affecting the sealing function of the closure according to the invention, whilst ensuring that the seal has some give at pressures significantly above 7 bar. The relative dimensions of the elements of the screw cap listed above, as shown in the figures and in the scales mentioned above, should therefore be preserved as far as possible within a range of ± 20%. However, different relative dimensions could be useful and necessary in particular if the principles of the present invention are to be applied to container closures in which container necks have considerably different dimensions (in particular different diameters and wall thicknesses) from the embodiments represented here.